

Mountaintop Mining/Valley Fill Environmental Impact Statement Technical Study

Work Plan for Fill Hydrology Proposal by Jim Eychaner U.S. Geological Survey 7/27/99

I. Introduction

This proposal to study the hydrology as it relates to valley fills associated with surface mining operations in West Virginia was developed by Jim Eychaner, Water Resource Division, U.S. Geological Survey (USGS). The study was prepared in consultation with the U.S. Office of Surface Mining Reclamation and Enforcement (OSM) and other Federal and State agencies. USGS is prepared to carry out this study cooperatively with the State of West Virginia on a 50-50 matching basis. The project will provide field measurements which will greatly enhance the ability of government agencies to address an issue which is of great concern to West Virginia citizens living in the vicinity of valley fills and to environmental groups concerned about the aquatic impact of valley fills.

The study findings will be incorporated into the overall assessment of the effects of large scale surface mining, particularly mountaintop mining operations in West Virginia. Companion study and information collection efforts are being carried out by four Federal agencies and the West Virginia Division of Environmental Protection (WVDEP) to support the programmatic Environmental Impact Statement (EIS) on mountaintop mining and associated valley fills currently being prepared under the National Environmental Policy Act.

II. Problem Statement

Considerable concern exists relating to the impacts of mountaintop mining on the waters of the United States. Understanding changes in flooding potential and in the availability of aquatic habitat at medium and low flow is fundamental to this purpose. Various components of this study will assess the effects of mountaintop mining on watersheds at several scales.

Mountaintop mining transforms a landscape of undisturbed sedimentary rock into poorly sorted rock fragments with large interconnected pores that may be voids and/or filled with varying amounts of detritus. The mountaintop mining environment affects many aspects of water movement. A direct approach to developing an understanding of the system described is through measurement of its behavior. Measurements are needed at both the smallest subbasin scale and at the cumulative basin scale.

III. Existing Information

A. Storm Runoff from Mining Fills

It has been documented that storm runoff among five small basins in Wyoming County WV decreased as the amount of mining increased (Borchers and others, 1991). Although 20 percent of the area of one of the basins had been surface mined, the largest effects noted were caused by underground mining.

Runoff in five small basins in the coal areas of West Virginia during 1972-73 was simulated by Puente and Atkins (1989). They estimated flows from the basins under pre-mining conditions and during hypothetical climate changes. More than 20 percent of two of the basins had been mined underground, and a maximum of 9 percent of one basin had been surface mined.

Runoff from three small watersheds in Ohio was measured between 1976 and 1985 before, during, and after surface mining (Bonta and others, 1997). National Resource Conservation Service runoff curve numbers generally increased during mining and reclamation.

B. Ground water

Coal-field residents tend to associate perceptible changes in their well water with the large disturbance visible in surface mines. The principal complaints are turbidity, taste and odor, and staining. Samples by WVDEP often show high fecal bacteria counts but rarely show chemical changes that would be expected from mining. These effects can be either transient or long-term.

Studies by the Kentucky Geological Survey at the Starfire mine site showed that a significant ground-water reservoir develops in large fills. The water, however, was generally unsuitable for domestic use.

The effects of mining and valley fills on water quality in domestic wells under transient conditions can be examined only in the presence of active mining at variable distances from the sample wells. Frequent access to wells to compare changes in water quality and aquifer hydraulics would be needed, which is nearly impossible when using domestic wells. Ideally, a number of wells would be installed in different settings around an active mine and examined thoroughly with logs, hydraulic tests, and chemical samples. Water level recorders on several wells would track any sudden changes associated with blasting. The study would continue as the distance between the active mine works and the test wells changed, and the wells would be re-examined as before.

A study along these lines was completed for the US Bureau of Mines during 1980-82 by Phillip R. Berger and Associates at four sites. A summary published in Bureau of Mines Information Circular 9135 suggests that transient turbidity effects are not rare.

IV. Ongoing Studies

A. Rainfall-Runoff Simulations

The Pittsburgh District of the U.S. Army Corps of Engineers has been evaluating the potential for flooding as a result of large-scale surface coal mining since September 1998 under an interagency agreement with OSM (Agreement number 143868-IA98-12244). The work includes simulation of three basins before and after mining for 10- and 100-year storm events.

A second site is anticipated in upper Cabin Creek (Kanawha County) or Island Creek (Logan County). The only gaging stations USGS has operated near the candidate model basins were discontinued at least 15 years ago. Near Cabin Creek, USGS gaged two small (<1.5 mi²) tributaries of Slaughter Creek during 1982-84. In the Island Creek basin at Whitman, a gage on Whitman Creek of Coperas Mine Fork (10.9 mi²) operated from 1969-77.

B. Ecological Measurements

The EIS Streams study has selected more than 100 sites where measurements of water chemistry,

aquatic invertebrates, and discharges will be made over a 12-month period. The sites include basins that are mined and unmined and also have other disturbances, such as logging.

A group of scientists at West Virginia University is studying terrestrial and aquatic ecology and surface hydrology in several small basins near the Hobet 21 mine complex in Boone County.

C. Low Flow and Habitat

Aquatic invertebrates and physical habitat were assessed during 1998 at 57 sites in the coal areas of West Virginia and Pennsylvania as part of the USGS National Water-Quality Assessment (NAWQA) program. The sites were among about 180 where water chemistry at base flow was compared to previous samples from about 1980. The sites generally were in basins of between 5 and 80 mi². Mining type (surface, underground, both, or none) and date (before or after 1980, or both) were identified for each basin. The EIS inventory of valley fills will be used as one indicator of mining activity in the basins. A report on study results will be published before April 30, 2000.

D. Groundwater

During 1997-98, the USGS NAWQA program studied recently-constructed domestic wells in good physical condition that are immediately down gradient from surface coal mines where reclamation was completed between 2 and 12 years earlier, in comparison to wells not near mines. These results, which represent long-term effects, will be interpreted and published before March 31, 2000, and can provide context information for the EIS, although valley fill sites were not included in the study. No ongoing work specific to the mountaintop mining areas is available.

A review and extension of the Bureau of Mines transient-effects study by Berger and Associates could provide valuable information about the functioning of Appalachian Plateau aquifers in general as well as about the near-field transient effects of surface coal mining.

V. Methods to Address Information Needs

To build upon studies to date, and provide measurements within the time frame of the EIS, the following two projects are needed:

A. Continuous Rainfall-Runoff Measurements

Measure rainfall and runoff continuously in three nested small basins and one separate, larger basin. The three basins include one that has been heavily mined, one that is unmined, and one downstream that receives the flow from both plus other mined and unmined areas. Regular communication and coordination with all agencies and researchers interested in the results will be maintained. Data from all sites will be distributed as needed to meet deadlines on projects in other agencies, and USGS will provide technical reviews of related modeling as requested.

This proposal covers site selection, installation of stream and rain gages, data collection for one year, and distribution of data to all parties. Because of the significant expenditure needed to establish the study infrastructure, USGS recommends that options be explored to continue the data collection through a second or third year, at lower cost. Representative flood measurements require that significant floods occur, which cannot be guaranteed within one year.

The complete data set will be made available in a convenient form for use by any interested researcher. If the study is extended beyond one year, USGS will analyze and report the results

using appropriate statistical and simulation techniques, in addition to simulation models undertaken by other agencies.

Measurements should be made in basins where the amount of mining does not change during the period of data collection. Data collection to support simulations of flooding for the EIS must account for two variables. First, floods result from uncontrollable times and amounts of rainfall, and each reaches a different peak discharge. A series of events is needed for model calibration, and other events are needed to test the calibrated model. Second, the flood resulting from an identical storm would differ as mining progresses and an increasing fraction of the basin is disturbed. The measurements, therefore, must control the controllable variable in order to usefully measure the uncontrollable one.

The data to be collected in this project are of interest to several agencies and individuals. USGS will establish a coordination mechanism to keep all interested parties aware of current progress and to invite feedback. At a minimum, information from USGS internal project reviews (about every 4 months) will be distributed to the parties.

Site selection

A triplet of nested basins will provide useful opportunities to develop understanding and test models. Data from one small unmined basin and one heavily mined basin will allow model calibration on end members in the mining process. Data for a downstream site that receives the flow from both small basins plus other mined and unmined areas will permit the model to be tested at a slightly larger scale. A more extreme test of model transferability will come from data in a significantly larger basin that does not include the triplet.

For example, the triplet could be in the Mud River basin at the Hobet 21 mine site. Main Ballard Fork is below Valley Fill number 12 in a basin of about 133 acres. The entire basin has been mined and the site provides an excellent example of a completed end-dump fill. Spring Branch is a tributary of Ballard Fork in an unmined basin of about 420 acres. Ballard Fork near its mouth occupies about 1350 acres, about half of which has been mined, and includes both other sites. Efficient field operations are possible, as the three sites are within 1.5 miles of each other. Finally, the large test site could be on Clear Fork near Whitesville WV (62.8 mi²), where an existing stream gage has been the site of substantial data collection within the USGS NAWQA program since 1996.

Final site selection will be made in coordination with all interested parties after funding becomes available. In addition to the target land-use characteristics, each useful site will have a stable relation between stream stage and discharge, will not have significant flow that bypasses the gage, will be accessible under most conditions of flow and weather, and will provide for safe measurement of high flows. Permission of landowners and consideration of the security of equipment and personnel also are factors.

Targeting data collection and modeling in the same basins is important in developing process understanding. The difficulties of finding sites where good data can be collected, however, suggest that modeling efforts should follow the field site selections rather than vice versa.

Field procedures

A continuous-record stream gage and at least two rain gages will be installed as soon as possible in each basin, generally within 90 days after funding is made available. A valid rating curve will be

established by field measurements. USGS will measure daily rainfall and streamflow at each site, along with rainfall and streamflow records at intervals of 15 minutes or less for all large runoff events. At the completion of work, USGS will remove equipment and restore the sites to prestudy conditions.

Ideally, the project would measure flow that passes through the valley fill in the heavily-mined basin separately from surface stormflow in perimeter drains or spillways. The valley fill sites thus far inspected in the field, however, have perimeter drains or spillways that converge on the previous stream channel within a few feet of the point at which ground water exits the fill. USGS will inspect spillways and perimeter drains after high-flow events and attempt to determine if any flow occurred there but will not attempt to maintain continuous records.

Most high flow events in West Virginia occur during the winter and spring, but major storms during low base flow in late summer also are valuable in model calibration. A complete understanding of the hydrologic effects of large fills requires measurement of runoff events during both winter and summer conditions. For optimum results, measurements at each site should continue for at least two complete water years, and three would be ideal.

Data review and distribution

As soon as discharge rating curves are available, USGS will begin to process the field data on a regular schedule, following standard procedures for quality assurance. Approved daily and event data will be distributed to the interested parties, including USACE and the EIS contractor, in time for their use in related studies. Each full year of data will be published in the annual USGS data report and archived in its national database.

At the end of the project, the complete data set will be made available in a convenient form for use by any interested researcher. Potential formats include distribution on a CD-ROM or via the internet. In addition to the hydrologic data, the release could include GIS data developed during USGS analysis and modeling of the basins, if that work is funded. A data set that combines hydrologic data with complete physical basin characteristics is expected to be widely useful in engineering education and research.

Data analysis and interpretive reports

To be valuable, the understanding to be developed through this project and related projects by other agencies must be made available to decision makers and the public. Therefore, two threads of interpretation and reporting will be maintained. USGS will participate with other agencies throughout the project life as they develop models that use these data by joining in model development discussions and providing technical reviews as requested. These discussions can close the loop between observations and simulations and provide a productive opportunity for greater understanding overall.

In addition, if resources beyond the EIS year become available, USGS would analyze the data from the study basins using appropriate statistical and simulation techniques and report the results. This analysis would include a thorough characterization of the surface and undisturbed subsurface topography of the triplet basins, the area and volume of fill materials, areas of identified land use, and relevant characteristics of natural or engineered channels and ponds. This analysis would be expected to identify runoff curve numbers specific to West Virginia mining conditions. These numbers are routinely used to design water control structures at mine sites.

Schedule and Budget

Federal Fiscal Year	Principal Tasks	Estimated Cost
1999	Select sites, install gages in 2 basins, begin to develop discharge ratings	\$ 54,000
2000	Complete installations and ratings, distribute early data, quantify basin characteristics	137,000
	Total:	\$191,000

If a decision is made later to continue the study, the field measurements and coordination with other interested researchers would cost \$115,000 per year. After the field work ends, the cost to decommission the sites, analyze the results, and publish the full data set and interpretive report would be \$90,000. USGS recommends a minimum of two, and preferably three, total years of data collection.

B. Minimum Flow and Aquatic Habitat

Construction of a valley fill could change the minimum-flow regime in a small basin, converting it from ephemeral to perennial, and could also change the higher-flow regime that washes fine-grained material from areas of coarse streambed and maintains habitat quality. The presence of both water and coarse bed material are important aspects of the aquatic habitat for many species.

The minimum-flow regime will be quantified by a series of discharge measurements, and the quality of the bed material will be assessed by standard pebble-size counting. The measurements will be made in 60 headwater basins selected, as much as possible, from the more than 100 sites used by the EIS Stream Team for sampling benthos and chemistry. Equal numbers of basins will be selected that have large valley fills, smaller fills, and no fills.

Field procedures

Discharge measurements at each site will be made four times during low flow. To the extent practicable, these measurements will be made on the same dates that samples of water chemistry or aquatic invertebrates are collected by other agencies. This coordinated work will provide discharge data for some samples and will provide some opportunity for training staff from other agencies in discharge-measurement techniques.

Habitat quality measurements will be made at the same time as one of the discharge measurements. Three representative cross sections will be identified in each stream reach. A modified Wolman pebble count will be made, selecting 100 samples of bed material among the three sections and measuring the intermediate axis length of each. At each section, the width and cross-sectional area of the wetted channel will be measured along with the width and height of the bankfull channel. Pebble counts have been a standard measure of habitat assessment for many years, the technique is easily learned by environmental technicians, and data reduction is much easier than identifying and counting invertebrates.

Data analysis and reports

The discharge measurements will be used to develop equations to estimate flow at the sample sites from concurrent flow recorded at one or more continuous-record gaging stations. A consistent low-flow statistic, such as annual mean 7-day low flow or the lowest 7-day discharge in 1999, will be computed for the gaging stations and estimated for the sample sites. The estimated low-flow statistics will be compared among the groups of basins to evaluate the effect of valley fills on minimum flow, and the proportion of perennial and ephemeral streams in each group will be estimated.

Estimation of minimum-flow statistics depends on the availability of continuous streamflow data at sites comparable to the sample sites. USGS presently maintains only 3 gages at sites that might serve for correlation purposes, and all have drainage areas in excess of 60 square miles. The results of work proposed in this section would be more reliable if some new gages were established under the rainfall-runoff measurement project.

The habitat-quality measurements will be compared among the groups of basins to evaluate the effects of valley fills on physical habitat. The results will be compared to similar measurements by USGS during 1998 in 57 larger streams in coal-mining areas of central West Virginia and western Pennsylvania.

The results of the study will be published in a USGS report.

Schedule and Budget

Streamflow is usually low enough for the measurements proposed in this project between June and October, although in some years low flow may arrive as early as May or continue as late as December. If the results are to be delivered to the EIS contractor by March 31, 2000, funding must be available promptly so that the field work can be completed during July-October 1999.

Federal Fiscal Year	Principal Tasks	Estimated Cost
1999	Select sites, 2 or 3 discharge measurements, pebble counts	\$40,000
2000	Complete discharge measurements, review & analyze data, publish interpretive report	23,000
	Total:	\$63,000

USGS recommends that the work be done during 1999 and reported by March 2000. Alternatively, however, the work could be scheduled for the summer of 2000 and the report completed by December 2000. The total cost would be the same.

VI. Projected Study Costs for Both Projects

Federal Fiscal Year	Continuous rainfall-runoff measurements	Minimum flow and aquatic habitat	Total
1999	\$ 54,000	\$ 40,000	\$ 94,000
2000	\$ 137,000	\$ 23,000	\$ 160,000
Total	\$ 191,000	\$ 63,000	\$ 254,000

If the State of West Virginia or one of its agencies provides the resources, USGS expects to

match the State contribution equally from Federal funds appropriated to USGS. The State share of the cost would be \$127,000.

For further information regarding this Work Plan, please contact:

Mr. James H. Eychaner of the U.S. Geological Survey at (304)-347-5130 ext 225, or e-mail eychaner@usgs.gov.

Bernard R. Maynard, Ph.D. of the Office of Surface Mining at (412) 937-2873, or e-mail bmaynard@osmre.gov.